



U.S. Department  
of Transportation  
**Federal Highway  
Administration**

1200 New Jersey Ave., SE  
Washington, D.C. 20590

November 10, 2010

In Reply Refer To:  
HSSI/CC-108

Mr. Felipe Almanza  
TrafFix Devices  
160 Avenida La Pata  
San Clemente, CA 92673

Dear Mr. Almanza:

This letter is in response to your request for the Federal Highway Administration (FHWA) acceptance of a roadside safety system for use on the National Highway System (NHS).

Name of system:	TrafFix Devices Sentry End Treatment
Type of system:	Crash Cushion
Test Level:	NCHRP Report 350 TL-2
Testing conducted by:	KARCO Engineering
Task Force 13 Designator:	Pending
Date of request:	November 11, 2009
Date of completed package:	April 29, 2010
Request initially acknowledged:	February 1, 2010

You requested that we find this system acceptable for use on the NHS under the provisions of the National Cooperative Highway Research Program (NCHRP) Report 350 “Recommended Procedures for the Safety Performance Evaluation of Highway Features.”

**Requirements**

Roadside safety devices should meet the guidelines contained in the NCHRP Report 350 or the American Association of State Highway and Transportation Officials’ Manual for Assessing Safety Hardware (MASH).

**Description**

The TrafFix Devices test level 2 (TL-2) Sentry End Treatment is a terminal for the TrafFix Devices Sentry Water-Cable Barrier. The Sentry End Treatment consists of three sections made of high density polyethylene (HDPE). The Sentry End Treatment sections and the Sentry Water-Cable Barrier sections are identical in shape and size. The end treatment sections are yellow in color, whereas the barrier sections are white and orange. Each end treatment section is



freestanding with an approximate width, height, and length of 22-1/2 inches, 46 inches, and 84 inches respectively. Each section has 11 connecting lugs, with 5 of them on one end and six on the opposite end.

Each of the four upper lugs on each Sentry End Treatment section contains an independent corrosion resistant steel wire rope. A 1-1/8-inch diameter steel T-pin drops through the 1.5-inch diameter holes in the lugs, linking the sections together. The empty weight of each wall segment is approximately 160 pounds, prior to them being filled with water.

Upon installation, each of the end treatment sections is filled to a depth of approximately 9 inches of water ballast. The first Sentry End Treatment section will have a rounded steel end cap marked with retro-reflective materials. The second and third sections, in the area of the end treatment cavity above the water are pre-filled with energy attenuating foam.

The weight of the first section, when filled with water, is approximately 520 pounds. The second and third sections weigh approximately 550 pounds because of the additional weight of the foam.

The sections are set in position, connected by the T-pin and T-pin keeper, and filled with water to the indicated level. The second and third sections have previously had the foam installed with a pathway through the foam for filling with water. Anti-rotation spacer frames are installed on the rearward end of each consecutive Sentry End Treatment sections. Filling the space between two connecting elements eliminates the rotation between the sections. Enclosure 1 illustrates detailed design drawings and general layout of the end treatment.

### **Crash Testing**

The Sentry End Treatment was crash tested by KARCO Engineering according to NCHRP Report 350 test designations 2-40, 2-41, 2-43, and 2-44 guidelines. As described above, the test article consisted of three yellow sections which measured 19.3 ft. The test article was linked to 12 to 14 Sentry Water-Cable Barrier sections (orange and white) according to this chart:

Test Number	Number of Sentry Sections
2-40	Fourteen
2-41	Twelve
2-43	Twelve
2-44	Twelve

The overall length of the test article ranged from 94.8 ft to 106 ft, 8-3/8 in.

In all of the tests the test vehicles remained upright. The post-impact trajectory of the test vehicles show that the vehicles did not rebound into adjacent lanes. All occupant risk values are below the preferred limits in all four tests. Enclosures 2 through 5 summarize the results of test 2-40 through 2-44 respectively.

## Findings

According to NCHRP 350, test designations 2-40, 2-41, 2-42, 2-43, and 2-44 are to be conducted for non-redirective gating crash cushions for TL-2. All of these tests were conducted except test designation 2-42. The system described above and shown in Enclosure 1 passed all tests which were conducted. In your letter you requested test 2-42 be waived. Your request is accepted on the grounds that the main purpose for test 2-42 is evaluation of Occupant Impact Velocity (OIV) and Occupant Ridedown Acceleration (ORA) when a small car (820 kg) impacts the crash cushion. However, the 820C vehicle impacted the system head on (with 1/4 of vehicle width offset) and the OIV and ORA are below preferred limits. The design of the crash cushion is such that it provides more stiffness longitudinally than laterally. Consequently, it is expected that the crash cushion would have passed test 2-42 had it been conducted. The Traffix Devices TL-2 Sentry End Treatment system is designed to be attached to a minimum of ten and without limit to the maximum number of Sentry Water Cable Barrier sections.

The system described above is acceptable for use on the NHS, when such use is acceptable to a highway agency.

Please note the following standard provisions that apply to FHWA letters of acceptance:

- This acceptance is limited to the crashworthiness characteristics of the systems and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number CC-108 and shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed at our office upon request.
- Because some water ballasted barriers and channelizers are similar in appearance, the FHWA recommends labeling each unit or module to indicate limitations on use. When used as a barrier all hardware, both internal and external that was used in the crash testing, shall be installed per the manufacturer's instructions. Recommended guidance for such labels may be found on the Web site of the AASHTO/AGC/ARTBA Task Force 13 at <http://www.aashtotf13.org>.

- Traffix Devices barriers and terminals are patented products and considered proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS projects, (a) they must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes. Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.
- This acceptance letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the candidate system, and the FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,



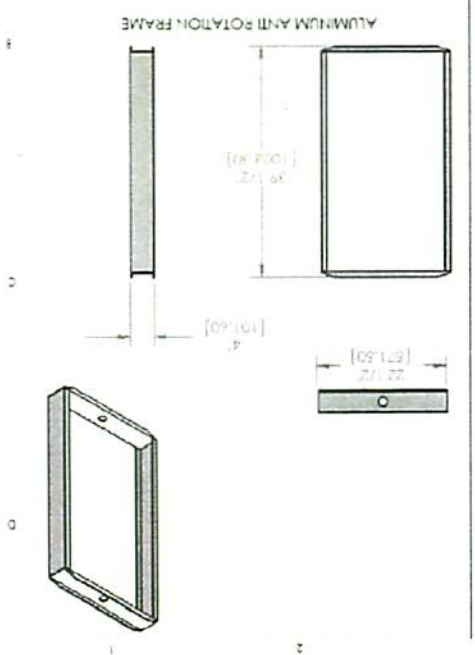
Michael S. Griffith  
Director, Office of Safety Technologies  
Office of Safety

5 Enclosures

DRAWING NO. 310  
 SHEET 1 OF 1  
 REV. A  
 TITLE: ENTRY WATER CABLE END TREATMENT HARDWARE  
 DATE: 08/11/11  
 DRAWN BY: [REDACTED]  
 CHECKED BY: [REDACTED]  
 APPROVED BY: [REDACTED]

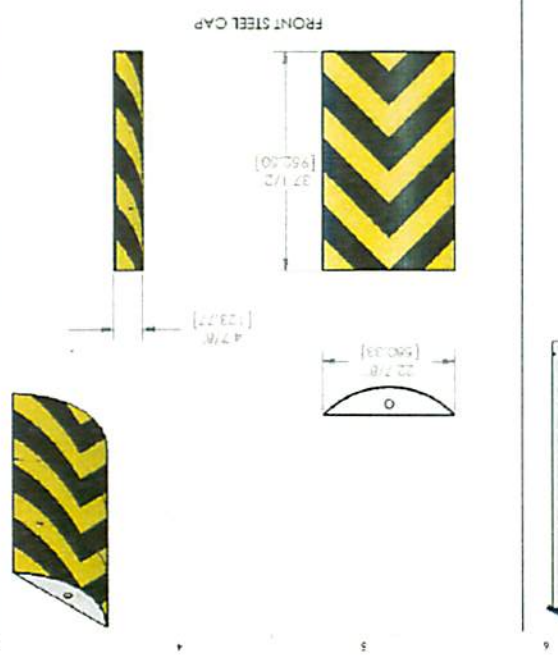
**TRITRIX** Devices Inc.  
 150 ALEXANDER LANE  
 SUITE 100, WILLOW PARK  
 WILLOW PARK, ONTARIO  
 L4Y 1W7  
 TEL: (905) 709-1000  
 FAX: (905) 709-1000  
 WWW.TRITRIXDEVICES.COM

ALL DIMENSIONS ARE IN ORIGINAL UNITS UNLESS SPECIFIED OTHERWISE.  
 DIMENSIONS: 4" X 22 1/2" X 39 1/2"  
 MATERIAL: ALUMINUM  
 UNITS: INCHES [mm]  
 NOTES: UNLESS OTHERWISE SPECIFIED



DRAWING NO. 310  
 SHEET 1 OF 1  
 REV. A  
 TITLE: ENTRY WATER CABLE END TREATMENT HARDWARE  
 DATE: 08/11/11  
 DRAWN BY: [REDACTED]  
 CHECKED BY: [REDACTED]  
 APPROVED BY: [REDACTED]

ALL DIMENSIONS ARE IN ORIGINAL UNITS UNLESS SPECIFIED OTHERWISE.  
 DIMENSIONS: 4" X 22 1/2" X 37 1/2"  
 MATERIAL: STEEL  
 UNITS: INCHES [mm]  
 NOTES: UNLESS OTHERWISE SPECIFIED



DRAWING NO. 310  
 SHEET 1 OF 1  
 REV. A  
 TITLE: ENTRY WATER CABLE END TREATMENT HARDWARE  
 DATE: 08/11/11  
 DRAWN BY: [REDACTED]  
 CHECKED BY: [REDACTED]  
 APPROVED BY: [REDACTED]

ALL DIMENSIONS ARE IN ORIGINAL UNITS UNLESS SPECIFIED OTHERWISE.  
 DIMENSIONS: 1/8" X 37" X 42 1/2"  
 MATERIAL: STEEL  
 UNITS: INCHES [mm]  
 NOTES: UNLESS OTHERWISE SPECIFIED

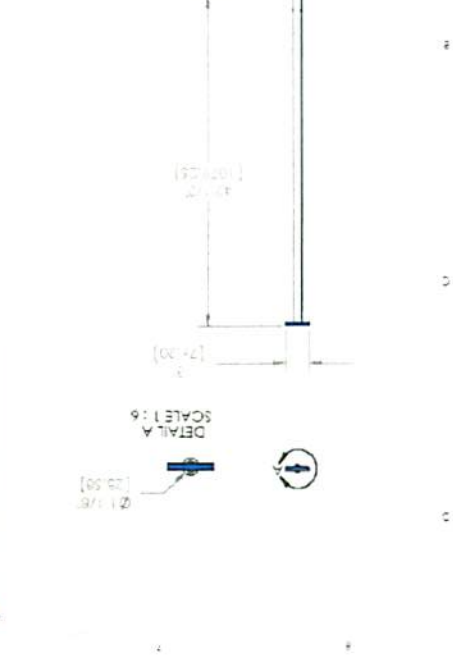


Figure 49: Manufacturer's Drawing

Enclosure 1

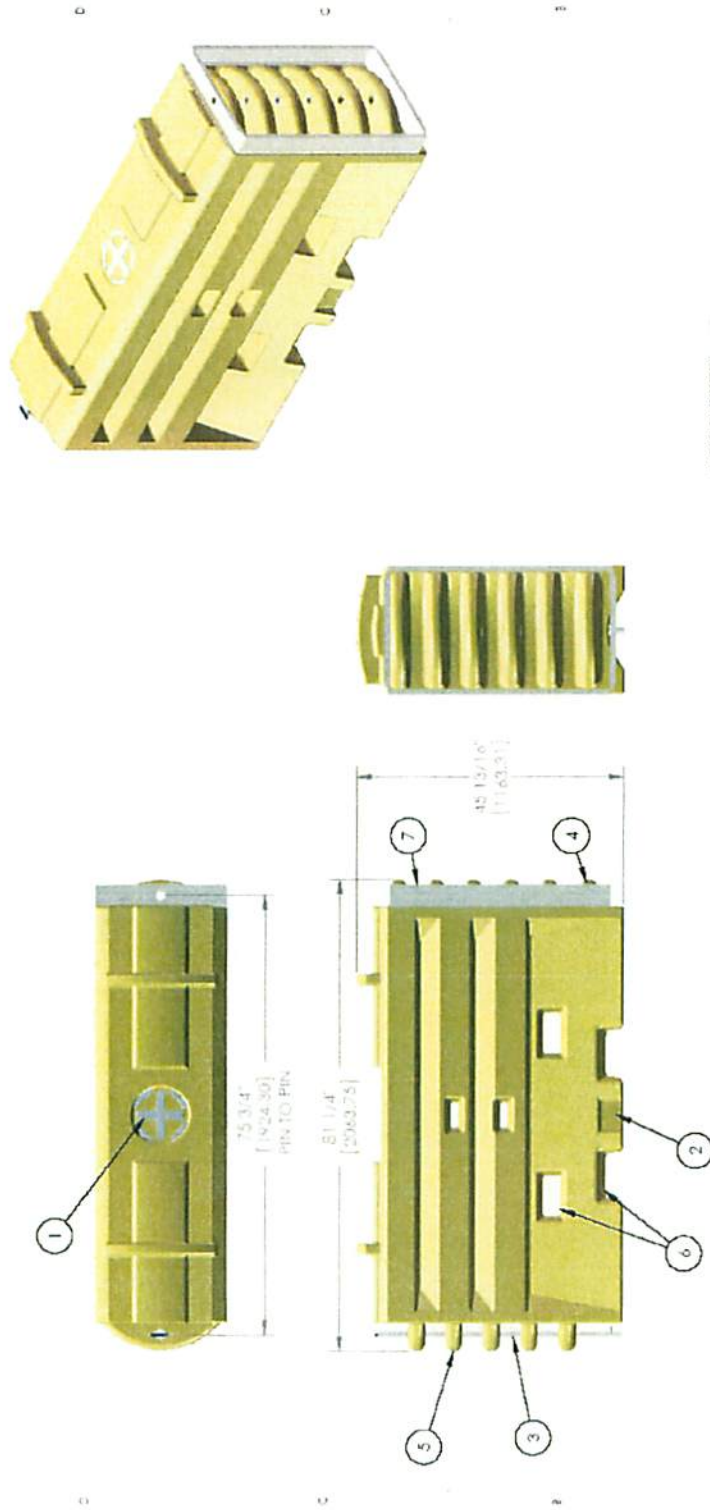


Figure 50: Manufacturer's Drawing

**TrafFix**  
**Devices Inc.**  
150 Avenida La Playa  
 San Diego, CA 92108  
 (619) 517-5000  
 www.traffixdevices.com

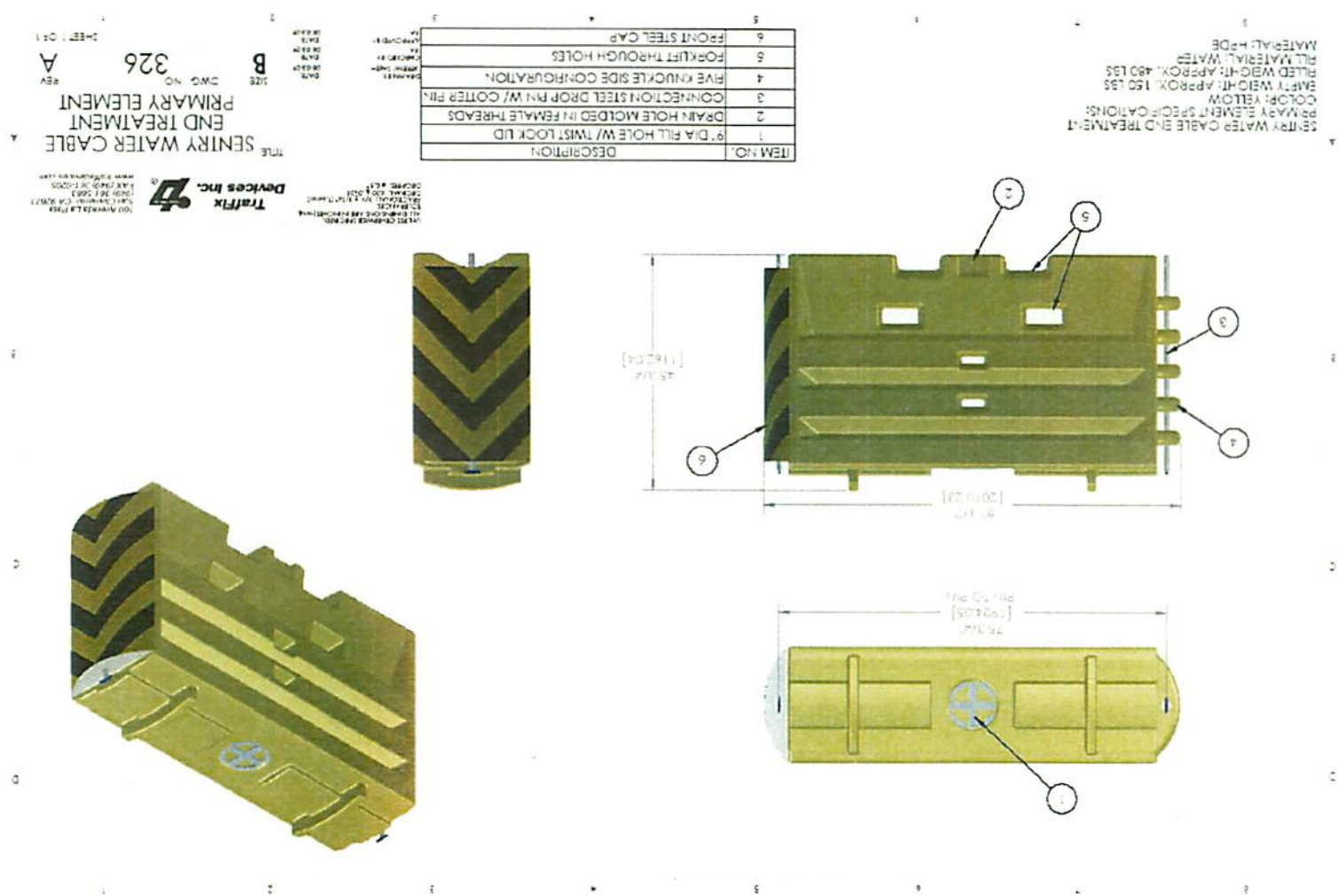
14135 Camino del Rio N.  
 Suite 100, San Diego, CA 92108  
 (619) 517-5000

**TITLE** FOAM FILLED SENTRY WATER  
 CABLE END TREATMENT  
 SECONDARY ELEMENT  
**REV** A  
**SIZE** B  
**DWG NO** 316  
**REV** A  
**DATE** \_\_\_\_\_  
**DATE** \_\_\_\_\_  
**DATE** \_\_\_\_\_

ITEM NO.	DESCRIPTION
1	1" DIA FILL HOLE W/ TWIST LOCK LID
2	DRAIN HOLE MOLDED IN FEMALE THREADS
3	CONNECTION STEEL DROP PIN W/ OUTER PIN
4	SIX KNUCKLE SIDE CONFIGURATION
5	FIVE KNUCKLE SIDE CONFIGURATION
6	FORKLIFT THROUGH HOLES
7	ALUMINUM ANTI-ROTATION FRAME

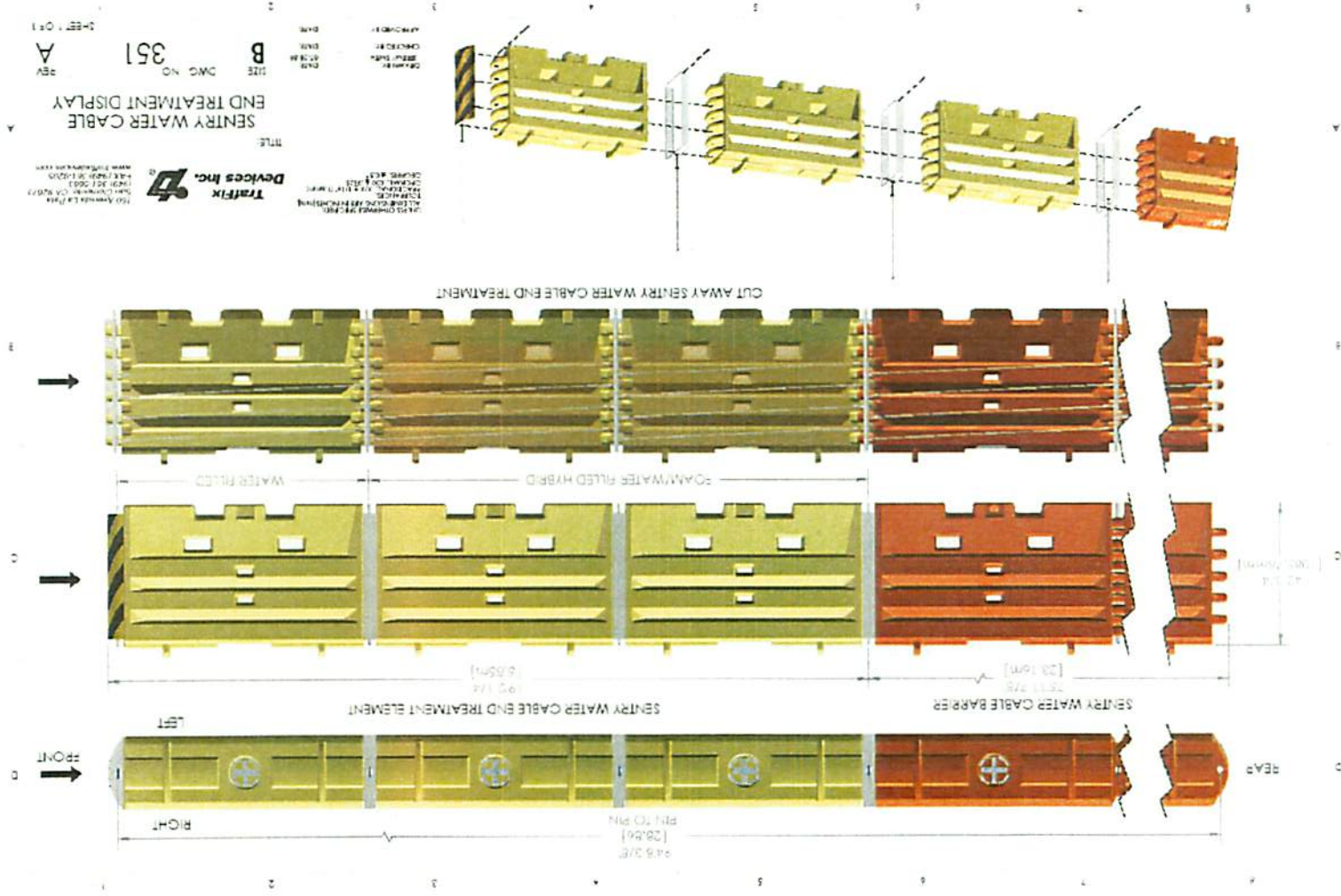
**FOAM FILLED SENTRY WATER CABLE END TREATMENT  
 SECONDARY ELEMENT SPECIFICATIONS:**  
 COLOR: YELLOW  
 EMPTY WEIGHT: APPROX. 150 LBS  
 FILLED WEIGHT: APPROX. 500 LBS  
 FILL MATERIAL: FOAM/WATER  
 MATERIAL: HDPE

SHEET 1 OF 1



Enclosure 1

Figure 51: Manufacturer's Drawing



Enclosure 1

Figure 52: Manufacturer's Drawing



**DATA SHEET 4**  
**SUMMARY OF RESULTS**

Test Article: TrafiX Devices Sentry End Treatment  
 Test Program: NCHRP 350 2-40  
 Test Vehicle: 1996 Geo Metro

Project No.: P29128-01  
 Test Date: 08/06/09



GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO Engineering, LLC	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	2-40	X DIRECTION	8.5
DATE	8/6/2009	Y DIRECTION	0.8
TEST ARTICLE		THIV (Optional)	N/A
TYPE	Crash Cushion	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH	34.8 m (114.2 ft.)	X DIRECTION	-5.8
SIZE AND/OR DIMENSION OF KEY ELEMENTS	Nominal Mass 226.8 kg (500 lbs)	Y DIRECTION	2.1
SOIL TYPE AND CONDITION	Concrete	PHD (Optional)	N/A
TEST VEHICLE		ASI (Optional)	N/A
TYPE	Production Model	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	820C	DYNAMIC	N/A
MODEL	1996 Geo Metro	PERMANENT	N/A
MASS (CURB)	803.0 kg (1771 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	811.0 kg (1788 lbs)	EXTERIOR	
DUMMY MASS	75 kg (165 lbs)	VDS	12-FR-5
MASS (GROSS STATIC)	886.5.0 kg (1955 lbs)	CDC	12FRMW3
IMPACT CONDITIONS		INTERIOR	
VELOCITY (km/h)	70.5 km/h (43.8 mph)	OCDI	FS0010000
ANGLE (°)	0.1	POST-IMPACT VEHICULAR BEHAVIOR	
IMPACT SEVERITY (kJ)	155.5	MAXIMUM ROLL ANGLE (°)	16.8
EXIT CONDITIONS		MAXIMUM PITCH ANGLE (°)	-9.7
VELOCITY (km/h)		MAXIMUM YAW ANGLE (°)	-195.1
ANGLE (°)			

**DATA SHEET 4**  
**SUMMARY OF RESULTS**

Test Article: TraFFix Devices Sentry End Treatment  
 Test Program: NCHRP 350 2-41  
 Test Vehicle: 1993 Chevrolet Silverado

Project No.: P29137-01  
 Test Date: 08/19/09



GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO Engineering, LLC	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	2-41	X DIRECTION	6.6
DATE	8/19/2009	Y DIRECTION	0.5
TEST ARTICLE		THIV (Optional)	
TYPE	Crash Cushion	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH	29.0 m (95.2 ft.)	X DIRECTION	-5.1
SIZE AND/OR DIMENSION OF KEY ELEMENTS	Nominal Mass 226.8 kg (500 lbs)	Y DIRECTION	2.5
SOIL TYPE AND CONDITION	Concrete / Asphalt	PHD (Optional)	
TEST VEHICLE		ASI (Optional)	
TYPE	Production Model	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	2000P	DYNAMIC	
MODEL	1993 Chevrolet Silverado	PERMANENT	
MASS (CURB)	2124.5 (4685 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	2007.0 (4425 lbs)	EXTERIOR	
DUMMY MASS	0.0 kg (0 lbs)	VDS	12-FC-5
MASS (GROSS STATIC)	2007.0 (4425 lbs)	CDC	12FCEN2
IMPACT CONDITIONS		INTERIOR	
VELOCITY (km/h)	71.36 (44.3 mph)	OCDI	FS0000000
ANGLE (°)	0.8		
IMPACT SEVERITY (kJ)	394.3	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (°)	6.0
VELOCITY (km/h)		MAXIMUM PITCH ANGLE (°)	1.8
ANGLE (°)		MAXIMUM YAW ANGLE (°)	-10.5

**DATA SHEET 4**  
**SUMMARY OF RESULTS**

Test Article: TrafFix Devices Sentry End Treatment  
 Test Program: NCHRP 350 2-43  
 Test Vehicle: 2000 Chevrolet Silverado

Project No.: P29138-01  
 Test Date: 08/19/09



GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO Engineering, LLC	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	2-43	X DIRECTION	7.0
DATE	8/19/2009	Y DIRECTION	1.0
TEST ARTICLE		THIV (Optional)	N/A
TYPE	Crash Cushion	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH		X DIRECTION	-4.7
SIZE AND/OR DIMENSION OF KEY ELEMENTS	Nominal Mass 226.8 kg (500 lbs)	Y DIRECTION	-2.0
SOIL TYPE AND CONDITION	Concrete	PHD (Optional)	N/A
TEST VEHICLE		ASI (Optional)	N/A
TYPE	Production Model	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	2000P	DYNAMIC	N/A
MODEL	2000 Chevrolet Silverado	PERMANENT	N/A
MASS (CURB)	2148 kg (4735 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	2044 kg (4506 lbs)	EXTERIOR	
DUMMY MASS	N/A	VDS	1-FR-4
MASS (GROSS STATIC)	2044 kg (4506 lbs)	CDC	01FREW2
IMPACT CONDITIONS		INTERIOR	
VELOCITY (km/h)	70.1 km/h (43.6 mph)	OCDI	FS0000000
ANGLE (°)	14.5	POST-IMPACT VEHICULAR BEHAVIOR	
IMPACT SEVERITY (kJ)	24.3	MAXIMUM ROLL ANGLE (°)	-23.5
EXIT CONDITIONS		MAXIMUM PITCH ANGLE (°)	-7.1
VELOCITY (km/h)	41.2 km/h (25.6 mph)	MAXIMUM YAW ANGLE (°)	13.8
ANGLE (°)	20.5		

**DATA SHEET 4**  
**SUMMARY OF RESULTS**

Test Article: TraFFix Devices Sentry End Treatment  
 Test Program: NCHRP 350 2-44  
 Test Vehicle: 1989 Chevrolet Silverado

Project No.: P29143-01  
 Test Date: 08/27/09



GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO Engineering, LLC	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	2-44	X DIRECTION	6.3
DATE	8/27/2009	Y DIRECTION	0.7
TEST ARTICLE		THIV (Optional)	
TYPE	Crash Cushion	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH	29.0 m (95.2 ft.)	X DIRECTION	-4.1
SIZE AND/OR DIMENSION OF KEY ELEMENTS	Nominal Mass 226.8 kg (500 lbs)	Y DIRECTION	3.6
SOIL TYPE AND CONDITION	Concrete / Soil	PHD (Optional)	
TEST VEHICLE		ASI (Optional)	
TYPE	Production Model	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	2000P	DYNAMIC	
MODEL	1989 Chevrolet Silverado	PERMANENT	
MASS (CURB)	2245.0 kg (4949.3 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	1976.0 kg (4356.3 lbs)	EXTERIOR	
DUMMY MASS	N/A	VDS	1-FR-4
MASS (GROSS STATIC)	1976.0 kg (4356.3 lbs)	CDC	01FREW1
IMPACT CONDITIONS		INTERIOR	
VELOCITY (km/h)	73.0 km/h (45.4 mph)	OCDI	FS1010000
ANGLE (°)	19.4		
IMPACT SEVERITY (kJ)	45.1	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (°)	-32.8
VELOCITY (km/h)	Unavailable	MAXIMUM PITCH ANGLE (°)	-12.8
ANGLE (°)	Unavailable	MAXIMUM YAW ANGLE (°)	-32.2